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# Remittances, Migration and Informality in Mexico. A Simple Model

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31. March 2008

Online at <http://mpra.ub.uni-muenchen.de/8373/>

MPRA Paper No. 8373, posted 23. April 2008 14:49 UTC

# Remittances, Migration and Informality in Mexico. A Simple Model<sup>\*</sup>

*José BRAMBILA MACIAS*

## **Abstract**

In this paper, we analyse the possible channels through which informality, remittances and migration could interact and consequently affect growth in Mexico. In order to do so, we develop a simple endogenous growth model that allows for remittances and the coexistence of the formal and informal sector in the production function. In the literature, there is no agreement regarding the effects of the informal sector on economic growth. Moreover, thanks to globalization, migration and remittances have increased significantly their macroeconomic weight, renewing interest in studying the interactions that these variables might have, especially in developing countries like Mexico, where remittances are the third source of income after oil and tourism revenues. Our model shows that remittances play a crucial role on enhancing the Mexican resource constraint, while the possibility of migration in the informal sector drains the aggregate labor force. However, the magnitude of potential remittances may offset this loss, thus having an overall positive effect on economic growth.

JEL Classification Numbers: F22, F24, O40, O17.

Keywords: Growth, Informal Sector, Migration, Remittances.

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<sup>\*</sup> I would like to thank Guido Cazzavillan and Ignazio Musu for their suggestions and comments. I am responsible for any errors and omissions.

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## A. Introduction

In the past decades, we have witnessed the spread of globalization. Never before, the world economy has known the magnitude of flows between countries that we can see today<sup>1</sup>. Commerce has boomed around the world thanks to a wide range of trade agreements, while massive migrations attracted by wealth poles are reshaping countries and societies. The outcome, and so the final verdict regarding the positive or negative effect of globalization, is still an open question. Some economic variables, that in the past seemed to play a marginal role, are now acquiring unexpected relevance. Remittances, informality and migration, for example, are increasing their importance in many rich and developing countries, although the exact influence that they have on growth is still uncertain or at most ambiguous.

In this paper, we deal with the possible interactions that these variables may have among them and the ways they could affect economic growth in Mexico. So, we focus on two central questions: What is the potential impact of the informal sector on economic growth? and through which channels remittances and migration can interact and affect economic development through informality?

Empirical evidence on the relationship between informality and economic growth is contradictory. On one hand, Helderber and Knepel (1988), Loayza (1997) and Kaufmann and Kaliberda (1996) find a negative relation; on the other hand, Tedds (1998), Giles and Tedds (2002), and more recently Chaudhuri et al. (2006) find a positive impact of informality on growth.

In the same way, remittances are believed to have both positive and negative impacts on developing countries. De Bruyn and Wets (2006) disaggregate these effects into three levels: macro, regional and household level. First, at a macro level (depending on the relative size of remittances with respect to the rest of the economy), remittances are believed to reinforce the national balance of payments by provision of foreign exchange, but, at the same time, they can deteriorate the balance of trade by inducing imports and the appreciation of national currency. Second, at a regional level, remittance inflows could boost up the local economy and finance development projects, but they can also widen inequality gaps between poor families and ignite inflation. Finally, in household terms, remittances can relax family budget constraints allowing them to meet basic needs as consumption, health and even education. Unfortunately, they are rarely used for productive investment and could create “dependency” inducing receivers to neglect local productive activities.

To round up the picture, migration is re-shaping the economic interactions between Mexico and the United States. According to the Pew Hispanic Center<sup>2</sup>, in 2005 the undocumented population in the United States reached about 11 million, from which about 60 percent were Mexicans. This is a huge mass of people operating at the margins of informality in both countries. If on top we add remittances sent through informal channels, we cannot neglect the effects that the informal sector is having on the Mexican economic growth. Hence, our decision to develop a simple endogenous growth model able to capture both positive and negative impacts of the previous flows, having in mind the Mexican scenario and characteristics.

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<sup>1</sup> In the last century, remittances and illegal migration have experienced a striking increase. According to the Economist, (January 5<sup>th</sup>-11<sup>th</sup> 2008) –*Special Report on Migration*–), remittances from the U.S. to Europe in 1907 accounted for only \$6.2 billion US dollars, while in 2007 we are in the range of \$240-300 billion US dollars, both in real terms.

<sup>2</sup> Pew Hispanic Center (2005) “Estimates of the Size and Characteristics of the Undocumented Population”, <http://pewhispanic.org/reports/report.php?ReportID=44>

In the following two sections we will provide a brief overview of the main variables of interest of this paper (i.e. informality, remittances and migration). The rest of the paper is structured as follows. First, we present a simple theoretical model that examines the possible channels through which increases of informality could affect the Mexican economy. Next, we run some simulations using stylized facts and parameters obtained from our previous empirical exercises. Finally, we conclude and present some possible policy implications.

## **B. Informality**

In this work, for simplicity reasons, we define informality<sup>3</sup> as the share of the aggregate labor force that is totally unregulated (e.g. second unregistered jobs, unskilled workers without social security, clandestine immigrants not allowed to work in a foreign country, etc.). Theoretically informality is believed to affect the economy through negative externalities in rich countries, and it is widely believed that in a sense has moderate positive effects on poor and developing countries.

On one hand, informality through its activities creates a vicious cycle on tax revenue. Indeed, it deprives or drains resources from the government, since informal agents use to some extent public goods and services, generate income, but do not pay taxes. As a consequence, the central government is forced to rise taxes on the formal sector, hence putting more pressure on formal agents, giving them incentives to switch to informality. Furthermore, informality is believed to distort official prices and wages, adding noise to formal markets. On the other hand, the informal sector is the only way through which many people can have access to sources of income, especially in poor countries (see IADB 2006).

One of the first attempts to model the informal sector was done by Loayza (1997), who used an extension of an AK model with two types of production functions, one for each sector (formal-informal). In his model, the size of the informal sector is conditioned mainly by the tax rates, the strength of the enforcement system (i. e. police, legal system, etc.) and the productivity of public services relative to private services. This reasoning is at the base of many empirical studies that focus on taxes and corruption as the main variables explaining the existence of informality.

As we already discussed, measuring the size of informality represents a total challenge in the economic literature due to the lack of official records to which we could refer. Having this in mind, the literature offers a great variety of methods that we can group and summarize as follows.

First of all, we have the Direct Methods<sup>4</sup>. Usually these methods rely on voluntary anonymous surveys, collected by private or public institutions, and are subject to the usual drawbacks (politics, human errors, the willingness to cooperate, etc.).

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<sup>3</sup> Surveys regarding the informal sector are usually done by public institutions. In the Mexican case, INEGI, the National Statistics Institute, is in charge of such endeavour.

<sup>4</sup> The most common of the indirect methods is the currency demand approach. The interested reader can refer to Tanzi (1983), Ahumada et al. (2006) and Bovi (1999).

Second, we have the very popular Indirect Methods<sup>5</sup>. Here, researchers rely on discrepancies between different indicators to proxy the true size of the informal sector (i.e differences between official and actual labour force, differences between national expenditure and income statistics, and the famous “Currency Demand Approach”).

The last method is known as the Model Approach, and uses structural equations to model informality as a latent variable in order to capture its evolution through time. This method is also known as the MIMIC<sup>6</sup> method (multiple indicators, multiple causes method). Although not new to the literature, the MIMIC model was popularized recently by Schneider (2002) who used it to estimate the size of the informal economy in 110 countries around the world.

### C. Remittances and Migration

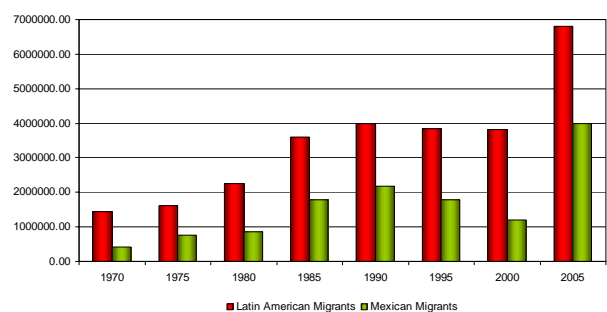
The other two variables of interest in this work are remittances and migration. In the past, the literature has dealt with migration inside a country (from the countryside to cities) and the possible interactions that these flows could have with growth and unemployment. The seminal work done on this subject can be tracked back to Harris and Todaro (1970) and Robertson and Wellisz (1977).

Nowadays, the scale of these flows is bigger in magnitude and broader in range than in the past. Indeed, we are witnessing massive migration flows to the developed countries of the world. Migration can be legal or illegal, temporary or permanent, skilled or unskilled and, in the same way as the informal sector, its relationship with growth is not clear.

In Figure 1 we can see the magnitude of Mexican migrant outflows over the past 30 years. It is important to point out that this figure refers to official or tractable migration, so it does not include illegal migration. Nevertheless, the figure is impressive, and according to the World Bank, Mexico experienced an outflow of near 4 million persons between 2000 and 2005. The majority of these outflows are directed to the U.S.

**Figure 1.**

**Net Migration**



Source: The World Bank's World Development Indicators. Note: Vertical axis measures the number of persons that migrate from the source country.

On the other hand and closely linked to migration we have remittances. Flows of remittances have been growing steadily in the past decades and have surpassed foreign assistance and foreign direct investment (FDI) in some cases<sup>6</sup>. Furthermore, remittances appear to be cyclically stable compared to other capital flows, see Maimbo and Ratha (2005), and Kapur (2005). Once more, their impact on growth is not completely clear, although they have become vital for some countries, in particular in some Central American, reaching an astonishing amount of 22.5 percent of GDP (see Figure 2). Empirical researchers use “recorded remittances” as a proxy, but the actual amount and the channels used to send the money are also affected by the shadows of informality. Indeed, the World Bank (2006) estimates that adding informal transfers will increase the official figure by

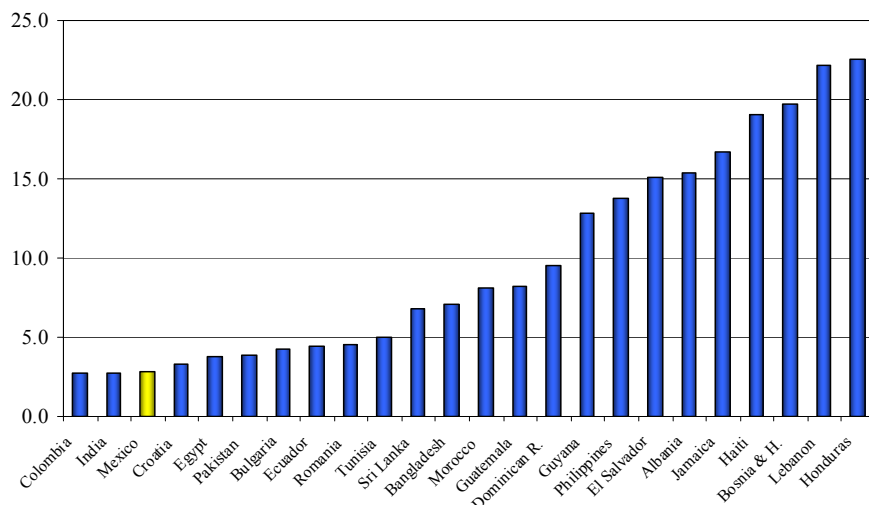
<sup>5</sup> Although simple versions of the model can be estimated using standard econometrics software, most practitioners use specialized packages as LISREL and AMOS.

<sup>6</sup> See World Bank (2006) and for the Mexican case refer to Lopez-Cordova (2006).

approximately 50 percent in some countries.

**Figure 2.**

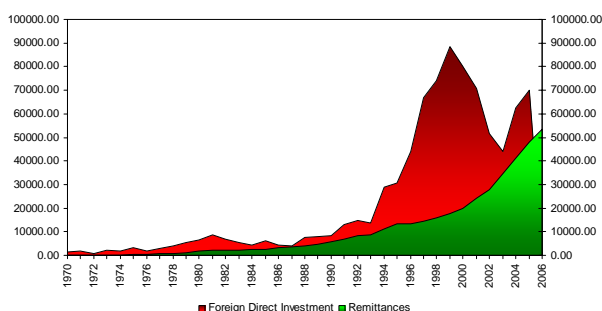
**Remittances to major receiving countries**



Source: OECD Factbook 2007b. Note: Remittances are in percentage of GDP, 2005. The data may exclude amounts Transferred that are less than a particular threshold value. Remittances transferred by informal methods or brought back by migrants in their pockets are not counted.

McCormick and Wahba (2000) study in a broader perspective the effects of remittances and overseas employment, analyzing the possible effects of population growth and family altruism (remittances), finding that remittances affect substantially the domestic expenditure and real exchange rates.

**Figure 3a. Foreign Direct Investment vs. Remittances in Latin America**

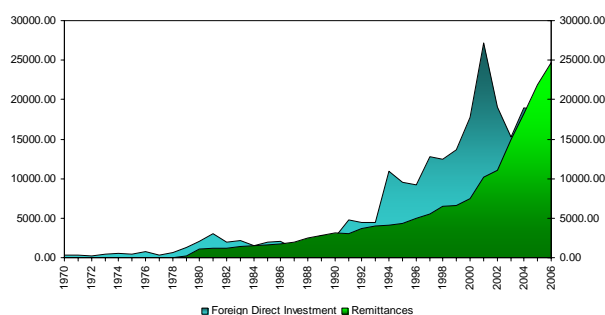


Source: World Bank's WDI. Note: Vertical Axis in millions of US dollars.

This amount is not only superior to what an unskilled worker would make in a formal job in Mexico (32 million Mexicans, about 75 percent of the Economic Active Population receive a salary in the range of 47 to 235 daily pesos, which is equivalent to \$4 or \$20 US dollars per day), but is also fairly stable over time and immune to national shocks. □ Actually, according to Chami et al. (2008) among others, the stability of remittances provides additional macroeconomic benefits by helping to reduce volatility of output and consumption in developing countries. This is one of the main

Figures 3a and 3b show the evolution of remittances and FDI during the past three decades in the Latin American Region, and in particular in Mexico. As we can see, remittances inflows have grown steadily and constantly until they became an essential source of income for many poor families in the region. According to the Mexican Central Bank statistics□, on average, Mexican recipients of remittances get circa \$340 US dollars every month from their relatives abroad.

**Figure 3b. Foreign Direct Investment vs. Remittances in Mexico**



Source: World Bank's WDI. Note: Vertical Axis in millions of US dollars

reasons propelling part of the existing literature that attributes to remittances the power of reducing poverty by helping agents to insure their consumption against negative shocks, helping enhance physical and human capital, as well as, alleviating credit constraints.

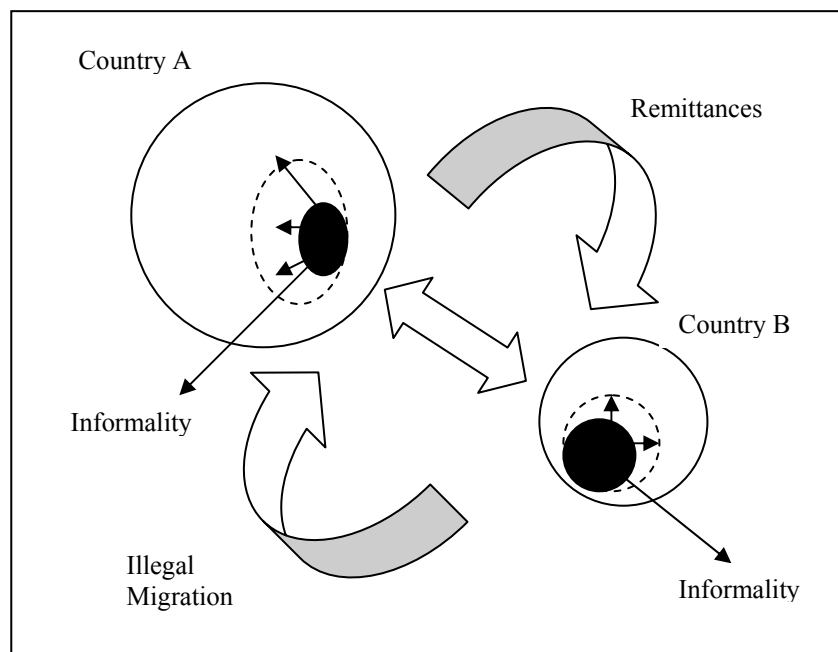
According to a recent study by the International Fund for Agricultural Development-IFAD (2007), remittances flows have been “hidden in plain view” for many years, although for many poor families around the world these flows represent the only helping hand capable or willing to lift them out of poverty, since the majority of them are used to cover basic needs (e.g. food, clothing, and housing).

Hence, many regional governments in Latin American countries and around the world have implemented economic policies oriented to enhance or attract these flows. However, relying only on remittances to fight poverty and improve macro stability could be risky if governments do not take the appropriate measures to ensure that these transfers enter the economic system as productive investment rather than only spurious consumption. Remittances are exposed to political shocks in the host countries (the tightening of migration laws) that could close or disrupt the inflows, heating severely the economies of many countries.

#### D. A Simple Model.

In a globalized world with free trade agreements in all continents, it becomes imperative to uncover the behaviour of informality and its reaction to new markets. Figure 4 diagrams the intuition behind our model. It presents possible channels that could lead to interactions between informality in different countries.

**Figure 4. Informality, migration and remittance interactions**



Country A (Foreign/Host) is capital intensive and belongs to the rich/developed economies, while country B (Home/Source) is labour intensive and forms part of the poor/developing economies. In autarky, country A and B have reached equilibrium on the size of their respective informal sectors.



The causes that gave origin to informality in each country can be different but we can assume that internal deficiencies like high taxes, bad institutional quality and adverse regulations are the main factors that propelled the underground economy in each country.

Now, when we open the economy of country A and B, we will find that country A has demand for unskilled labour which country B is willing to provide either in the formal or informal sector in country A. If regulations obstruct this flow, but demand remains unchanged, a market for illegal workers will enter the equation, increasing informality in country A. Foreign unskilled workers (legal or illegal) in country A will receive a wage. These workers will send back part of their salary in the form of remittances to their families at their home country B. The extra money could be used in country B to maintain or increase consumption, and also to finance the formal sector. But if the conditions that created informality in country B have not improved in the time being, this new income flows could also be used in the informal sector, explaining its increase also in country B.

In order to analyse some possible channels through which the existence of informality in one country could affect growth and informality in other countries, below we present a simple theoretical model. We will not deal with the causes of informality, we will assume that it exists and focus on its interactions. First of all, we will choose a type of production function that uses both formal and informal labor, allowing them to coexist in our economy.

Furthermore, the model will attempt to pin down some stylized facts uncovered by previous empirical studies dealing with the informal sector and remittances in the Mexican economy (see, e.g. Chapters one and two).

In our analysis we include the informal sector in our model focusing mainly on the labor force (usually research dealing with migration and remittances has focused mainly on a branch of the economic literature known as the “brain drain” in open economy models<sup>7</sup>). Thus, the production function for final output in our economy is given by:

$$Y = AK^\alpha (F^\psi S^{1-\psi})^{1-\alpha}, \quad 0 < \alpha < 1, \quad 0 < \psi < 1 \quad (1)$$

where  $A$  is the usual exogenous technology parameter,  $K$  is the capital variable, and aggregate labor<sup>8</sup> is formed by formal labor ( $F$ ) and informal labor ( $S$ ). Furthermore, in our model the share of labor  $\psi$  allocated to the formal sector is country specific.

Given that in the Mexican economy the migration flows interest mainly the informal and unskilled sectors, in this model we will allow only the informal workers to migrate<sup>9</sup>. So, in this context, both the formal and informal sectors grow at a different pace. On one hand, the formal workers exogenous growth rate will be given by  $x \geq 0$ , while on the other hand, informal workers natural

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<sup>7</sup> We direct interested readers on the previous treatment of the brain drain effects on source and host countries to works by Beine et al. (2001) and Saint-Paul G. (2004), while readers interested in the effects of migration and related variables on economic growth can refer to Larramona and Sanso (2006), Mountford (1997), Rebelo (1991) and Roubini and Milesi-Ferretti (1994) for a thorough treatment.

<sup>8</sup> The aggregate labor function is  $L = F^\psi S^{1-\psi}$ .

<sup>9</sup> The assumption of international immobility of one sector has been used mainly in brain drain studies. We refer interest readers to Pieretti and Zou (2006, 2007) for a complete treatment of aggregate labor using a CES function relating the skilled and unskilled sector.

growth rate  $j \geq 0$  has to be adjusted by the migration flows<sup>10</sup> ( $\gamma$ ), so that the final informal sector labor growth rate is defined as  $h = j - \gamma$ .

Due to the fact that in our model intra-labor substitutability is unitary, it follows that the aggregate growth rate of labor can be defined as follows:

$$n = x\psi + h(1-\psi), \quad x \geq h \quad (2)$$

A part of the informal workers that migrate (i.e Mexican “*wetbacks* / *braceros*” crossing the border to the U.S.) send back a part of the money that they make in the foreign country as *remittances* to their families in the source country.

Formally, we define remittances as follows:

$$REM = v \cdot W_{foreign} \cdot I, \quad 0 \leq v \leq 1 \quad (3)$$

where  $REM$  corresponds to a fix portion  $v$  of the foreign wage times the number of (Mexican ) migrants  $I$ .

Translating this into home country terms we get:

$$REM = v \cdot (1+z) \cdot W_S \cdot \varphi \cdot S, \quad z > 0, \text{ and } 0 < \varphi < 1 \quad (4)$$

In order to ensure enough incentives for migration, foreign wages are assumed to be higher than home informal wages ( $W_S$ ) in a fix proportion<sup>11</sup> ( $1+z$ ), while the total number of migrants  $I$  corresponds to a fraction  $\varphi$  of total informal sector workers ( $S$ ).

Therefore, informal and formal wages in this economy are defined respectively as follows:

$$W_S = \frac{Y(1-\alpha)(1-\psi)}{S} \quad (5)$$

and

$$W_F = \frac{Y(1-\alpha)(\psi)}{F} \quad (6)$$

Hence, the economy's resource constraint in the home country takes into account a significant cash flow in the form of remittances:

$$\dot{K} = AK^\alpha (F^\psi S^{1-\psi})^{1-\alpha} - \partial K - C + REM \quad (7)$$

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<sup>10</sup> We define the proportion of informal  $I$  sector migrants to the total informal sector workers as  $\gamma = I / S$ .

<sup>11</sup> According to the *Fair Labor Standards Act*, in the United States, the Federal minimum wage in 2007 was set to \$5.85 US dollars per hour, although many states and regions within the American Union have higher wages. On the other hand, Mexican minimum wages account to only \$47 MX Pesos on a daily basis. Just to give the reader an idea of the huge wage gap between the two countries, the Mexican salary is equivalent to \$0.54 US Dollars per hour, so in proportion the American minimum wages are 10 times higher than in Mexico.

It is important to point out that remittances<sup>12</sup> could enter the constraint with a negative sign if we were in the host country, since the latter correspond to outflows going from the host country to the source country (USA → Mexico), draining resources from the host's budget constraint.

Agents in our economy maximize the value of the discounted felicity function subject to the budget constraint. Formally, in our case the dynamic problem reads as follows<sup>13</sup>:

$$\begin{aligned} \max_c \int_0^\infty \frac{c^{1-\sigma} - 1}{1-\sigma} e^{-\rho t} e^{nt} dt \\ \text{s.t.} \quad \dot{k} = y - \delta k - nk - c + rem \\ k(0) = k_0 \end{aligned} \quad (8)$$

where we are assuming that the instantaneous felicity function has a constant intertemporal elasticity of substitution  $\frac{1}{\sigma}$ ,  $\rho$  represents the constant rate of time preference and  $n$  is population growth.

Setting up the Hamiltonian of the above dynamic problem we get:

$$H = \frac{c^{1-\sigma} - 1}{1-\sigma} e^{(n-\rho)t} + \lambda(y - \delta k - nk - c + rem) \quad (9)$$

Using the Keynes-Ramsey rule of optimal consumption and the first order conditions we can obtain the following dynamic system:

$$\dot{c} = \frac{c}{\sigma} ((Ak^{\alpha-1} \alpha (1 + (1+z)(1-\alpha)\nu\varphi(1-\psi))) - n - \delta - \rho) \quad (10)$$

$$\dot{k} = Ak^\alpha (1 + (1+z)(1-\alpha)\nu\varphi(1-\psi)) - k(n + \delta) - c \quad (11)$$

$$k(0) = k_0; \quad c(\infty) = \tilde{c} \quad (12)$$

---

<sup>12</sup> In our model remittances will increase with the pool of informal workers available for migration.

$rem = y^* (1+z)(1-\alpha)\nu\varphi(1-\psi)$ , where  $y = \frac{Y}{F^\psi S^{1-\psi}}$ .

<sup>13</sup> The functions were rewritten using the intensive form, where  $k = \frac{K}{F^\psi S^{1-\psi}}$ .

Next, we proceed to study the transitional dynamics of our model by linearizing our dynamic system around the steady state  $(\tilde{c}, \tilde{k})$  using the first-order Taylor approximation:

$$(c - \tilde{c})^\bullet \cong a(c - \tilde{c}) + b(k - \tilde{k}) \quad (13)$$

$$(k - \tilde{k})^\bullet \cong d(c - \tilde{c}) + f(k - \tilde{k}) \quad (14)$$

where

$$\begin{pmatrix} a & b \\ d & f \end{pmatrix} = \Delta = \begin{pmatrix} \frac{A k^{\alpha-1} \alpha ((1+z)(1-\alpha) v \varphi (1-\psi) + 1) - n - \delta - \rho}{\sigma} & \frac{A c k^{\alpha-2} (\alpha - 1) \alpha ((1+z)(1-\alpha) v \varphi (1-\psi) + 1)}{\sigma} \\ -1 & A \alpha k^{\alpha-1} + A(1+z)(1-\alpha) \alpha v \varphi (1-\psi) k^{\alpha-1} - n - \delta \end{pmatrix}$$

Consequently, defining  $\Delta$  as the coefficients matrix, and  $|\Delta|$  as its determinant, we can see that the trace of our matrix  $\text{tr}(\Delta) > 0$ , and the determinant  $|\Delta| < 0$ . So, this allows us to infer that our characteristic roots are real and of opposite sign, which confirms that we have a saddle-point stability<sup>14</sup>.

Computing the linearized system for the steady state we get the following solutions:

$$\begin{aligned} \hat{c} = & \left( \left( \frac{A \alpha (1 + (1+z)(1-\alpha) v \varphi (1-\psi))}{n + \delta + \rho} \right)^{\frac{1}{1-\alpha}} (-n - \delta) \right) + \\ & + A(1 + (1+z)(1-\alpha) v \varphi (1-\psi)) \left( \frac{A \alpha (1 + (1+z)(1-\alpha) v \varphi (1-\psi))}{n + \delta + \rho} \right)^{\frac{\alpha}{1-\alpha}} \end{aligned} \quad (15)$$

---

<sup>14</sup> The complete derivation and numerical analysis is provided in the Appendix.

$$\hat{k} = \left( \frac{A\alpha(1+(1+z)(1-\alpha)v\varphi(1-\psi))}{n+\delta+\rho} \right)^{\frac{1}{1-\alpha}} \quad (16)$$

From our model we can appreciate that besides the usual positive effects from technology and capital intensity, increases in the informal sector could have an overall enhancing effect on economic growth due to positive cash inflows that the economy gets through remittances.

This possible positive effect depends mainly on the size of the wage gap between the host and the source country<sup>15</sup>, as well as on size of the portion of foreign wage that the illegal foreign worker is willing or able to send back to his family in the source country.

If the wage gap is big enough to offset the drain of informal labor force in the source economy then increases in the informal sector could improve, at least in the short-run, economic growth.

To clarify this point in the next section we proceed to run some simulations using benchmark parameters from previous empirical studies (for more see the Appendix).

### E. Simulation

In this section, we perform a numerical exercise. The parameters used for the simulations of the benchmark model are reported in Table 1 in the Appendix.

First, we use the equations in the linearized system (13) and (14) in order to compute the eigenvalues and the eigenvectors of our model, which are reported in the table below:

**Table 1.**

	<b>1</b>	<b>2</b>
<b>Eigenvalues</b>	0.121023	-0.081023
<b>Eigenvectors</b>	<b>c</b> 0.080758	-0.120147
	<b>k</b> -0.996734	-0.992756

Second, we proceed to compute the solutions of the linearized system and run simulations of the adjustment processes.

Using the above eigenvectors and eigenvalues we can express the linearized system as follows:

$$c(t) = -0.120147B_2e^{-0.081023t} + 0.0807587B_1e^{0.121023t} + (-n-\delta)\left(\frac{A\alpha(1+(1+z)(-1+\alpha)v\varphi(-1+\psi))}{n+\delta+\rho}\right)^{\frac{1}{1-\alpha}} +$$

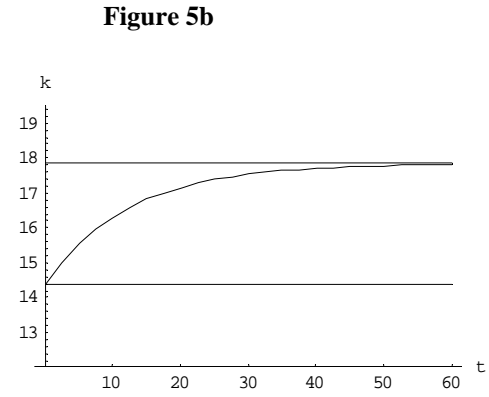
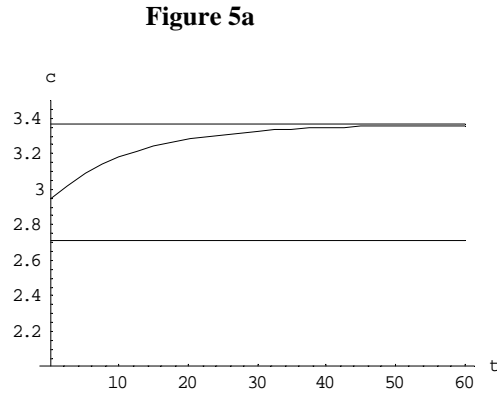
<sup>15</sup> The U.S. minimum wage is about 10 times higher than the Mexican one in current terms.

$$+ A(1 + (1 + z)(-1 + \alpha)v\varphi(-1 + \psi)) \left( \frac{A\alpha(1 + (1 + z)(-1 + \alpha)v\varphi(-1 + \psi))}{n + \delta + \rho} \right)^{\frac{\alpha}{1-\alpha}} \quad (17)$$

$$k(t) = -0.992756B_2e^{-0.081023t} + 0.996734B_1e^{0.121023t} + \left( \frac{A\alpha(1 + (1 + z)(-1 + \alpha)v\varphi(-1 + \psi))}{n + \delta + \rho} \right)^{\frac{1}{1-\alpha}} \quad (18)$$

In order to determine our arbitrary constants of integration  $B_1$  and  $B_2$ , we evaluate the solutions of our linearized system at  $t = 0$ <sup>16</sup>. Furthermore, we set  $B_1 = 0$  and solve for  $c(0)$  and  $B_2$ . Finally, we need to assign a set of initial and final parameters in order to graph the adjustment process of our final solutions.

### Solutions



Source: Author's calculations

Note: Horizontal axis represents time, while vertical axis measure consumption and capital respectively.

Once we got the solutions, we plot the results. Figure 5a represents the adjustment process for consumption, while Figure 5b describes capital over time.

As anticipated in the previous section, we now proceed to simulate increases in the informal sector in order to exemplify its possible impacts on economic growth. Figure 6 is divided in three panels: A, B and C. Panel A depicts the different effects on capital, panel B does the same for consumption, while panel C summarizes the several solution trajectories as well as the isoclines in the  $(k, c)$  space.

Column 1 represents the benchmark model, where the share of informality in the economy  $(1-\psi)$  is set to be 30 percent, while the wage differential  $(1+z)$  is fixed at 5 and illegal migrants are assumed to send back a preset portion  $v$  of their foreign wages in the form of remittances amounting to 1/2 of their total payment.

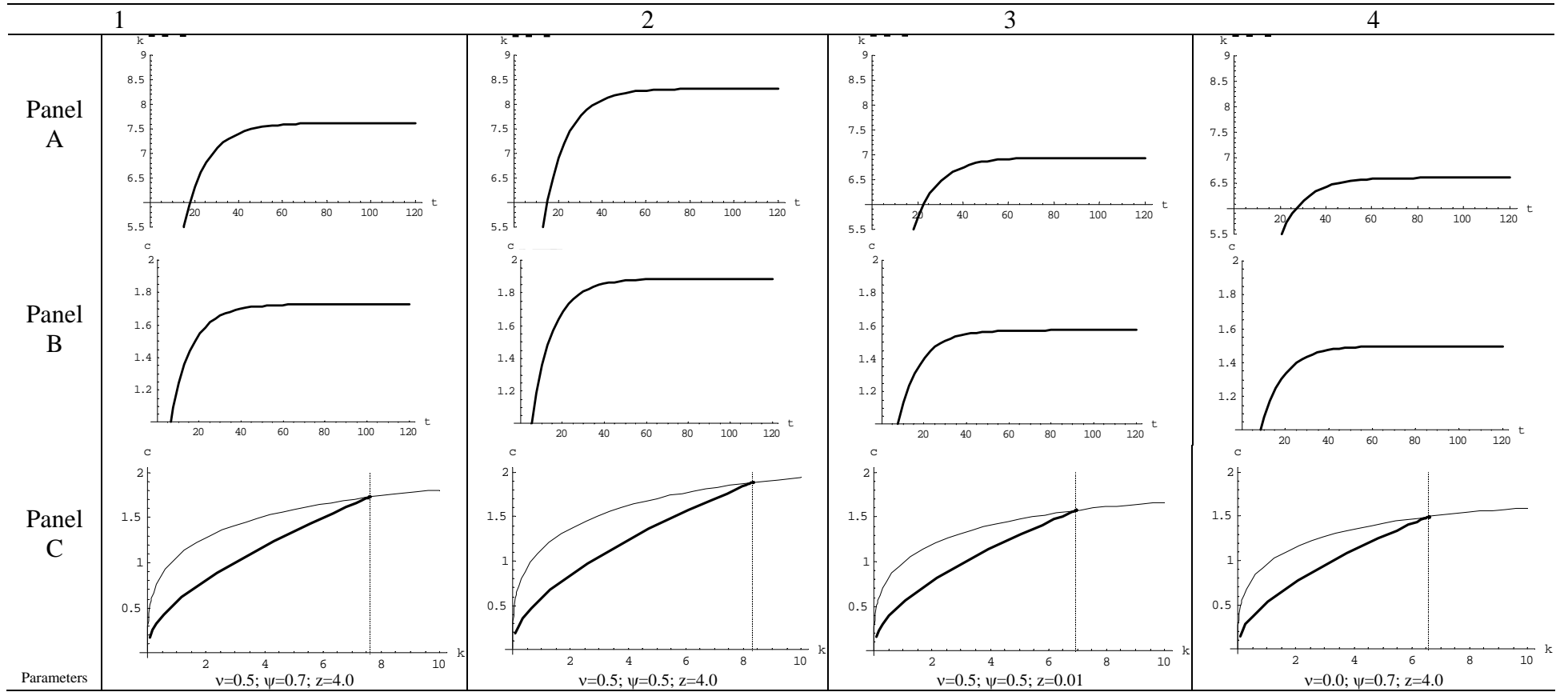
<sup>16</sup>  $c(0) = B_1\mu_{11} + B_2\mu_{12} + \tilde{c}$

$k(0) = B_1\mu_{21} + B_2\mu_{22} + \tilde{k}$

Starting from the benchmark model in Column 1, we augment the share of informal labor from 30 percent to 50 percent. This increase, helped by the wage differential, will have an overall positive impact on the economy clearly visible in Column 2. From Panel C we can appreciate that the isocline  $\hat{c} = 0$  moves rightward from 7.6 to 8.4 over the capital axis ( $k$ ), while isocline  $\hat{k} = 0$  increases, being intercepted by the solution trajectory at 1.7 on the consumption axis ( $c$ ). Nevertheless, the positive effect vanishes once the wage gap decreases significantly. *Ceteris paribus*, if we cut down the wage differential ( $1 + z$ ) from 5 to 0.01, the magnitude of the remittances inflows to the source country are not enough to offset the loss of aggregate labor, subtracting resources to the economy and therefore reducing growth. Column 3 diagrams these draining effects. From Panel C we can see how the isocline  $\hat{c} = 0$  decreases from 8.4 to 6.9 once we reduce drastically the wage gap.

Finally, on Column 4, we simulate a total interruption of remittances by setting  $v$  equal to zero, and compare the effects to the benchmark model. As expected, blocking remittances inflows will impact directly the budget constraint of our economy. So, from Panel C, we can observe a significant decrease of almost 1 point on the horizontal axis, settling at 6.5 units.

Figure 6. Dynamic Simulations



Note: Panel A and B plot the time paths of capital  $k(t)$  and consumption  $c(t)$ , while Panel C plots the isoclines with the different solution trajectories (bold line) in the  $(k, c)$  space. Column 1 depicts the benchmark model simulation and columns 2 to 4 show the variations due to changes in the informal sector parameters.



The previous simulations show the impact of alternative values for the share of informal labour and the channels through which they can affect differently and indirectly the source economy, in this case Mexico. Increases in the remittances flows are shown to enhance the Mexican resource constraint as long as the wage differential is high enough to offset the constant loss of labor force.

## F. Conclusions

In order to analyse the possible channels through which informality, remittances and migration could interact and consequently affect economic growth in Mexico, we develop a simple endogenous growth model that allows for remittances and the coexistence of the formal and informal sector in the production function.

In the Mexican case, assuming that only informal workers are willing to migrate and defining remittances as income transfers, we impose limitations to our model in such a way that, at the end, growth rates in our economy depend on the size of the informal sector in Mexico and on the wage differential with the United States. Furthermore, we simulate a possible disruption of remittance flows, and analyze the detrimental effects that this could have on the Mexican economy. Our model shows that remittances play a crucial role on enhancing the Mexican resource constraint, while the possibility of migration in the informal sector drains the aggregate labor force. However, the magnitude of potential remittances may offset this loss, thus having an overall positive effect on economic growth.

This is just half of the picture of the many possible interactions that may take place in the globalized economies of our days, and is certainly not exhaustive of the many channels through which informality, remittances and migration can affect growth in a country. Nevertheless, our model sheds some light on the fact that these macroeconomic variables can have different and sometimes contrasting effects in neighbouring economies, like Mexico and the U.S.

Our model can also provide some interesting policy implications. On one hand, it is clear that remittances represent a major and constant flow of very much needed income in poor segments of society. So, facilitating and improving these flows is vital to help fighting poverty and fostering economic growth. Governments should take measures to incentive senders to use formal channels and, at the same time, give the receivers the opportunity to use a share of their money to invest in the productive sectors of the economy through the development of special financial services. Doing so will allow governments to benefit indirectly from these flows by taxing a small portion of remittances and at the same time will enhance the economy in case of a sudden disruption of remittances.

From an empirical perspective, it would be interesting to conduct an empirical test of our model to validate our theory. However, as we explained in the introduction, the variables of interest are *per se* difficult to measure. Indeed, time series recording remittances and at some extent illegal immigration are available in different databases, but the availability and reliability of data related to informality are still scarce. Therefore, researchers may be forced to use alternative methods of estimation that might limit the strength of the empirical conclusions.

Finally, for future research, we believe it could be worth to relax the assumptions of our model, allowing for taxation, introducing frictions for migration, and enabling workers in both the formal and informal sector to migrate.

## Appendix

**Table 2. Simulation Parameters for the Benchmark Model**

Note: We tried to fix parameters the closest possible to observed empirical data and stylized facts within the Mexican economy.

<p><b>Capital Share</b></p> <p>Using previous empirical studies (see Loayza et al. 2005) we setup the benchmark capital share for the Mexican economy at <math>\alpha = 0.3</math></p>	<p><b>Population Growth Rate</b></p> <p>We set <math>n = 0.02</math>, this corresponds to the average population growth rate in the past three decades. 1970-2006.</p>
<p><b>Proportion of foreign wages sent as remittances</b></p> <p>The proportion of foreign wages sent as remittances is difficult to asses. Using data from the Mexican Central Bank and previous works by Pieretti and Zou (2006, 2007) we decided to set the quantity of repatriation of foreign wages at <math>\nu = 0.5</math></p>	<p><b>Technology Parameter</b></p> <p>For the sake of simplicity we set the technology parameter <math>A=1.0</math></p>
<p><b>Wage differential</b></p> <p>The minimum wage differential in current terms between the U.S. and Mexico is high, workers in the U.S. can earn 10 times what the same worker can make in Mexico; however, in order to take into account inflation and other local factors we decided to set it at <math>z = 4.0</math></p>	<p><b>Size of the informal sector</b></p> <p>According to the estimates of the first two chapters of this dissertation and INEGI, the percentage of informal workers could be set at <math>(1-\psi) = 0.3</math>.</p>
<p><b>Discount Factor</b></p> <p>We set the discount factor at <math>\delta=0.02</math></p>	<p><b>Migration</b></p> <p>Using the World Bank's WDI database we try to approximate the magnitude of migration flows, setting it at <math>\varphi=0.2</math></p>

## Saddle-Point Equilibrium

In order to confirm that we have a saddle-point equilibrium, we need to check the signs of the eigenvalues of our system of two differential equations after it has been linearized around the steady-state point.

The coefficient matrix of the linearized system is:

$$\begin{pmatrix} \frac{Ak^{\alpha-1}\alpha((1+z)(1-\alpha)v\varphi(1-\psi)+1)-n-\delta-\rho}{\sigma} & \frac{Ack^{\alpha-2}(\alpha-1)\alpha((1+z)(1-\alpha)v\varphi(1-\psi)+1)}{\sigma} \\ -1 & A\alpha k^{\alpha-1} + A(1+z)(1-\alpha)\alpha v\varphi(1-\psi)k^{\alpha-1} - n - \delta \end{pmatrix}$$

which has determinant

$$\begin{aligned} & [ (Ak^{\alpha-1}\alpha((1+z)(1-\alpha)v\varphi(1-\psi)+1)-n-\delta-\rho)(A\alpha k^{\alpha-1} + A(1+z)(1-\alpha)\alpha v\varphi(1-\psi)k^{\alpha-1} - n - \delta) \\ & \quad + \\ & \quad (Ack^{\alpha-2}(\alpha-1)\alpha((1+z)(1-\alpha)v\varphi(1-\psi)+1)) ] < 0, \end{aligned}$$

Now, using the benchmark parameters (see Table 2), we have that the determinant is  $-0.0126933 < 0$ , while the trace of our matrix is given by

$$(Ak^{\alpha-1}\alpha((1+z)(1-\alpha)v\varphi(1-\psi)+1)-n-\delta-\rho) + (A\alpha k^{\alpha-1} + A(1+z)(1-\alpha)\alpha v\varphi(1-\psi)k^{\alpha-1} - n - \delta)$$

and, again using the benchmark parameters, we get that our trace is  $0.04 > 0$ , ensuring that indeed we have a saddle-point equilibrium.

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